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**NPR 8705.3**

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**COMPLIANCE IS MANDATORY**

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## Safety and Mission Assurance (SMA) Requirements for Experimental Aerospace Vehicles (EAV) w/ Change 1 (3/30/04)

**Responsible Office: Office of Safety and Mission Assurance**

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## Change History

### Safety and Mission Assurance (SMA) Requirements for Experimental Aerospace Vehicles (EAV)

Chg #	Code/Center	Approved	Description/Comments
1	Q	3/30/04	Deletions of paragraphs, references, etc. per Jennings memo dated 12/5/03 and administrative changes made throughout to change NPG to NPR,

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# Preface

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## P.1 Purpose

This NPR implements the requirements of NPD 8700.2, NASA Policy for Safety and Mission Assurance (SMA) for Experimental Aerospace Vehicles (EAV) by providing the procedural requirements for assessing the SMA elements of EAV programs and projects as the basis for SMA flight assessment and/or a recommendation for third-party indemnification.

## P.2 Applicability

- a. This NPR applies to NASA Headquarters and NASA Centers, including Component Facilities, and to the Jet Propulsion Laboratory (JPL) to the extent specified in its contract with NASA.
- b. This NPR applies to any "Experimental Aerospace Vehicle" as defined by 42 U.S.C. 2458c (d)(3). For the purposes of this NPR, the term EAV includes a vehicle defined in 42 U.S.C. 2458c (d)(3) as: "an object intended to be flown in, or launched into, orbital or suborbital flight for the purpose of demonstrating technologies necessary for a reusable launch vehicle, developed under an agreement between the Administration and a developer." Additionally, the term EAV includes vehicles demonstrating reentry and landing technology in accordance with the above criteria. This NPR applies to the NASA-supported EAV program/projects during all mission phases, from development through postflight/completion.
- c. Requirements in this NPR are waived for aircraft operating in support of EAV missions at less than Mach 5 and 100,000 feet in altitude. Managers of programs and projects involving vehicles exceeding both parameters shall use this document (Requirement 21055).
- d. EAV programs/projects may request that the SMA Flight Assessment be issued by the NASA Center SMA Director vice the Associate Administrator for Safety and Mission Assurance.
  1. Requests may be made to the Center SMA Director of the Center that plans to perform the SMA preparations for flight, who shall obtain the concurrence of the Associate Administrator for Safety and Mission Assurance prior to granting the request. (Requirement 21056)
  2. Requests may be made if all of the following conditions apply:
    - i. The program/project is Center-managed (vice Headquarters-managed), and the Associate Administrator for Safety and Mission Assurance does not have a special interest in the program/project.
    - ii. The vehicle is not planned to become human flight rated.
    - iii. Third-party indemnification decision will not be requested.
  - iv. All flights are planned to fly on a single or contiguous Government range under the control of a single Range Safety Office.
- e. EAV programs/projects that are covered as a part of another Agency-level safety flight certification process (e.g., Space Shuttle) may request that the other process be utilized for SMA flight assessment. These requests are made jointly by the program/project manager with the program manager of the covering program via the Enterprise Associate Administrator to the Associate Administrator for Safety and Mission Assurance.
- f. When indemnification has been requested, this NPR covers only the SMA portion of the indemnification process that determines whether the developer is following SMA procedures and practices that are acceptable to NASA.

## P.3 Authority

- a. 42 U.S.C. 2473(c)(1), Paragraph 203(c) (1) of the National Aeronautics and Space Act of 1958, as amended.

b. 42 U.S.C. 2458c(b)(2)(D), section 309 of the National Aeronautics and Space Act of 1958, as amended.

## P.4 References

- a. 14 CFR Chapter III, Commercial Space Transportation, Federal Aviation Administration, Department of Transportation.
- b. National Security Telecommunications and Information Systems Security (NSTISS) Policy Number 12, National Information Assurance (IA) Policy for U.S. Space Systems.
- c. NPD 1000.1, NASA Strategic Plan.
- d. NPD 7120.4, Program/Project Management.
- e. NPR 8621.1, NASA Procedural Requirements for Mishap Reporting, Investigating, and Recordkeeping.
- f. NPD 8700.1, NASA Policy for Safety and Mission Success.
- g. NPD 8700.2, NASA Policy for Safety and Mission Assurance (SMA) for Experimental Aerospace Vehicles (EAV).
- h. NPD 8710.3, NASA Policy for Limiting Orbital Debris Generation.
- i. NPD 8720.1, NASA Reliability and Maintainability (R&M) Program Policy.
- j. NPD 8730.4, Software Independent Verification and Validation (IV&V) Policy.
- k. NPR 1441.1, NASA Records Retention Schedule.
- l. NPR 2810.1, Security of Information Technology.
- m. NPR 7120.5, NASA Program and Project Management Processes and Requirements.
- n. NPR 7900.3, Aircraft Operations Management.
- o. NPR 8000.4, Risk Management Procedural Requirements.
- p. NPR 8705.2, Human Rating Requirements for Space Flight Systems.
- q. NPR 8715.3, NASA Safety Manual.
- r. NPR 8735.2, Management of Government Safety and Mission Assurance Surveillance Functions for NASA Contracts.
- s. NSS 1740.14, Guidelines and Assessment Procedures for Limiting Orbital Debris.
- t. Reserved
- u. NSTS 1700.7, Safety Policy and Requirements for Payloads Using the Space Transportation System.
- v. NSTS/ISS 13830, Payload Safety Review and Data Submittal Requirements.
- w. SSP 30324, Failure Modes, Effects, and Criticality Analysis.
- x. SSP 30599, Safety Review Process.
- y. SSP 30695, Acceptance Data Package Requirements.
- a'. SSP 50004, Support Equipment Design Requirements.
- aa. SSP 50021, Safety Requirements Document for International Space Station.
- ab. SSP 50231, SMA Certification of Flight Readiness Implementation Plan.
- ac. Eastern and Western Range (EWR) 127-1, Range Safety Requirements.
- ad. Range Commanders Council Document 319-99, Flight Termination Systems - Commonality Standard.
- ae. Range Commanders Council Document 321-02, Common Risk Criteria for National Test Ranges, Inert Debris.
- af. Range Commanders Council Document 323-32, Range Safety Criteria for Unmanned Air Vehicles.
- ag. United States General Accounting Office Testimony, Space Transportation: Critical Areas NASA Needs to Address in Managing Its Reusable Launch Vehicle Program, (GAO-01-825T), June 20, 2001.
- ah. American National Standards Institute (ANSI)/American Institute of Aeronautics and Astronautics (AIAA) S-080-1998, Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components.

## P.5 Cancellation

None

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**/s/ Bryan O'Connor**  
**Associate Administrator for Safety and Mission Assurance**

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# CHAPTER 1. Overview

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## 1.1 Introduction

1.1.1 Current and future NASA technology development programs/projects include the design, development, and flight of EAV's.

1.1.2 Regardless of contract form or procurement type, complex and demanding aerospace programs/projects require the implementation of a minimum set of processes to assure safety, manage and minimize risk, and maximize the likelihood of mission success.

1.1.3 The EAV safety program shall address requirements of the ground environment as well as flight environment ([Requirement 21001](#)).

1.1.4 Reserved

1.1.5 This NPR describes the SMA program/project process requirements, roles, and responsibilities for EAV operations.

It also describes the process to be used by NASA SMA officials to assure compliance with SMA requirements. The Associate Administrator for Safety and Mission Assurance uses the SMA management process defined in this NPR to obtain the knowledge and information needed to support the providing of SMA Flight Assessment as a part of the flight readiness review process.

## 1.2 SMA Requirements for EAV Flights

1.2.1 A summary of nominal SMA elements is contained in paragraph 5.3 and Table 2. The program/project manager is responsible for ensuring that all of the elements in Table 2 have been addressed in a timely manner ([Requirement 21003](#)). The EAV certifying or performing Center SMA Director(s) is responsible for ensuring that the necessary SMA expertise is available to accomplish the SMA elements listed in Table 2 and that appropriate insight, oversight, and independent assessment is done to assure paragraph 5.3 is satisfied ([Requirement 30914](#)).

1.2.2 The Associate Administrator for Safety and Mission Assurance shall provide for each flight or set of flights, through signature of the SMA Flight Assessment (see Chapter 5), that the activities in paragraph 5.1, determined to be appropriate, have been successfully completed and that all identified mission safety risks have been demonstrated by the program/project to be controlled to an acceptable level for flight ([Requirement 21005](#)).

1.2.3 The program/project manager (in concert with the range safety officials) shall limit the collective risks associated with EAV operation (see Chapter 6 of NPR 8715.3, NASA Safety Manual) and ensure that the probability of doing harm to the public, astronauts and pilots, workforce, and high-value equipment and property meets the Federal and local range safety requirements (or applicable requirements if no local range authority exists) ([Requirement 21006](#)).

1.2.4 The EAV program/project must meet all local test range safety requirements ([Requirement 21007](#)). For EAV-managed mission phases, NASA EAV's shall meet the requirement for E<sub>c</sub> risk assessment below 30x10<sup>-6</sup> (see Appendix B, paragraph B.1) ([Requirement 30915](#)).

1.2.5 If human rating is a requirement of the EAV, and there are conflicts between NPR 8705.2, Human Rating Requirements for Space Flight Systems, and the processes called out in this document then NPR 8705.2 shall take precedence ([Requirement 21008](#)).

1.2.6 Launch safety, flight safety, and postflight processing safety shall be addressed as a part of the SMA Preflight Assessment Review (PAR) ([Requirement 21009](#)).

1.2.7 The reliability goal of the deorbit burn system to achieve controlled entry to the targeted landing site or debris

footprint shall be at least 0.99 ([Requirement 21010](#)). The intent is to provide reasonable assurance that the vehicle will be deorbited in a predictable manner (see Appendix B, paragraph B.3).

1.2.8 The EAV program/project shall preplan for orbital, suborbital, and entry flight by developing detailed flight rules, procedures, and checklists prior to Flight Readiness Review (FRR) (or equivalent), for both nominal and contingency operations ([Requirement 21011](#)). The EAV program/project shall document scenarios that allow for continued safe flight and landing or flight termination in a manner that minimizes risk in off-nominal situations. ([Requirement 30916](#)).

1.2.9 An entry operation shall not be initiated until conditions critical to safety have been confirmed ([Requirement 21012](#)). (This could be verified through review of procedures/flight rules.) Commit to deorbit shall be initiated (enabled) via EAV operator control ([Requirement 30917](#)).

1.2.10 Reserved

1.2.11 Appendix B provides a summary of range safety requirements from the Department of Defense (DoD) and the U.S. Federal Aviation Administration (FAA). Due to the fact that most EAV operations will require the use of non-NASA ranges, they are provided in the NPR to assist the program/project manager in understanding some of the fundamental range safety requirements that must be addressed for EAV operations.

1.2.12 For EAV flights which are performed outside of established U.S. ranges, any ranges involved in the EAV flight shall be included in the process in this NPR ([Requirement 21069](#)).

## 1.3 Third-Party Indemnification

A NASA EAV developer (contractor or industry partner) may request indemnification from the NASA Administrator for liability to third parties arising from the operation of an EAV, as EAV is defined in 42 U.S.C. 2458c(d)(3). Among other prerequisites to any grant of indemnification, the developer must "[establish] to the satisfaction of the Administrator that appropriate safety procedures and practices are being followed in the development of the (EAV)" ([Requirement 21013](#)). The signature of the Associate Administrator for Safety and Mission Assurance on the SMA Flight Assessment indicates the Associate Administrator's assessment that the developer has satisfactorily established that it is following appropriate safety procedures and practices.

## 1.4 SMA Management Process

1.4.1 The SMA management process is designed to identify and mitigate EAV risk to acceptable levels. The objectives of the SMA management process are to:

- a. Verify that the Enterprise Associate Administrator has defined and established specific safety, mission assurance, and risk management requirements for NASA EAV's. As part of the requirements definition process, the Associate Administrator for Safety and Mission Assurance (or SMA organization leading the SMA Flight Assessment) will conduct a SMA Process Readiness Review (PRR) (see Chapter 2).
- b. Verify ongoing implementation of SMA process requirements throughout the design, development, manufacturing, testing, and operation of EAV's. The Center SMA Director has primary responsibility, with support from NASA Headquarters, Center functional organizations, and program/project personnel, to implement EAV SMA processes. The verification step includes development of the Mission Assurance Surveillance Plan (see Chapter 3). The Mission Assurance Surveillance Record (see paragraph 3.3) provides the objective evidence to support SMA decisionmaking for EAV missions. The SMA organization(s) is responsible for the Mission Assurance Surveillance Plan and the Mission Assurance Surveillance Record.
- c. Verify that all the SMA activities, determined to be appropriate, have been successfully completed. Verify that all of the identified SMA risks have been controlled to an acceptable level. These will be required as a part of the flight assessment process in the SMA PAR (see Chapter 4).

1.4.2 The SMA flight assessments, recommendations, and certifications on knowledge and understanding will be obtained through objective evidence of policies, processes, tests, analyses, examination of process documentation, objective evidence of process implementation, confidence in reliability and analysis, and participation in the flight/operational readiness review process (see paragraph 5.1).

1.4.3 The Associate Administrator for Safety and Mission Assurance (or designated SMA official) will provide:

- a. Assessment of the EAV mission assurance process.
- b. Signature on flight or operational readiness documents (e.g., Certificate of Flight Readiness [CoFR]).



1.4.4 The Associate Administrator for Safety and Mission Assurance may designate, in writing, a NASA management official to represent the NASA Headquarters Office of Safety and Mission Assurance (OSMA) at EAV reviews. The designee is responsible for keeping the Associate Administrator for Safety and Mission Assurance apprised of all SMA issues and actions ([Requirement 21020](#)). The designee may or may not be delegated the responsibility to sign off on the SMA Flight Assessment.

## 1.5 Roles and Responsibilities

Table 1 delineates the roles and responsibilities of key organizations in the SMA management process for EAV's. It is the responsibility of the program/project manager to determine the level of support activity needed and to establish agreements with other NASA Centers, Federal agencies, and/or contractors to accomplish these roles ([Requirement 21021](#)).

### **NOTE:**

The managers listed in Table 1 are responsible for ensuring that the necessary work is assigned and carried out to the level indicated in the table ([Requirement 30918](#)). This table provides references to the documents where the requirements are established. References in bold are from this NPR.

Function	Associate Administrator for Safety and Mission Assurance	Enterprise Associate Administrator	Performing Center Director(s)	Certifying/Performing Center SMA Director(s)	EAV Program/Project Manager
Establish Agency SMA policies, procedures and guidelines, and standards (NPD 8700.1)	Lead				
Implement Agency SMA policies, procedures and guidelines, and standards. (NPD 8700.1 and Paragraph 1.4.1.a)		Lead (for Headquarters programs)	Lead (for Center programs/projects)	Verify	Implement
Develop flight certification process for each EAV program/project (NPD 8700.2, paragraph 5.b.2, 5.d, and 5.f.2)	Support	Lead(Enterprise process)	Lead(Center process)	Support	Lead (Program/Project process)

Ensure that all elements in Table 2 of paragraph 5.3 are addressed.  (Paragraph 1.2.1, and Chapters 3, 4, and 5)	Verify	Participate	Participate	Support and provide SMA insight/oversight and independent assessment	Lead
Conduct PRR or equivalent to evaluate the program/project-defined SMA processes  (Chapter 2)	Lead	Participate	Participate	Support	Support
Provide ongoing surveillance of assurance process implementation  (Paragraphs 3.1 and 3.2)	Verify		Support	Lead	Support
Provide program/project SMA status to NASA SMA management  (Paragraph 3.1.3)			Verify	Lead	Support
Establish and maintain mission assurance surveillance record over the life of the program/project  (Paragraph 3.3)			Support	Lead	Support
Develop SMA program/project plan  (NPR 7120.5)				Support	Lead
Conduct PAR or equivalent to verify implementation of SMA processes  (Chapter 4)	Lead	Participate	Participate	Support	Support
Develop and implement SMA flight assessment process  (Paragraph 5.1)	Participate	Participate	Support	Support	Lead

Execute/delegate EAV SMA flight assessment approval  (Paragraphs 5.1 and 5.3)	Lead			Support	
Accept residual risk  (Paragraph 1.2.2)	Support	Lead and coordinate with OSMA	Support	Support	Support
Process third-party indemnification requests  (Paragraphs 1.3 and 5.2)	Participate	Lead and coordinate with OSMA, Chief Financial Officer, and General Counsel	Support	Support	Initiated by contractor via program/ project manager

## Table 1 Terms:

Lead: Responsible for line item actions.

Support: Assist the lead in performing and accomplishing.

Participants: Awareness of program/project status issues and status.

Verify: Provide oversight and insight to ensure accomplishment and to ensure that policies and procedures have been implemented.

Implement: Actionee for policy and procedures.

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## CHAPTER 2. Define SMA Process Requirements

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### 2.1 Introduction

2.1.1 The EAV program/project manager shall develop an SMA plan with support of the Center SMA Director that documents the safety, risk management, and mission assurance process requirements and how they are to be verified ([Requirement 21022](#)).

2.1.2 OSMA (or delegated SMA official) shall conduct an SMA PRR, or equivalent, early in the program/project life cycle (e.g., during the requirement definition process) to validate that the program/project SMA plan has established adequate processes to support granting of SMA Flight Assessment ([Requirement 21023](#)).

2.1.3 The SMA PRR should coincide with a programmatic review nominally at or near the Preliminary Requirements Review, Systems Requirements Review, or the Phase 0/1 Safety Review or equivalent (date and location to be negotiated between the Associate Administrator for Safety and Mission Assurance and the Enterprise Associate Administrator [or designee(s)]).

2.1.4 The objective of the SMA PRR is for the Associate Administrator for Safety and Mission Assurance (and/or designee) and NASA Center SMA management personnel to review the acceptability of a program/project's proposed safety, risk management, and mission assurance processes.

2.1.5 OSMA may delegate the authority to conduct the SMA PRR to the Center SMA Director for programs/projects that are managed at the Center.

### 2.2 SMA PRR Protocol

- a. The Associate Administrator for Safety and Mission Assurance (or designee) chairs the SMA PRR.
- b. OSMA (or designee) develops the review agenda with the certifying/performing Center SMA organization at least 4 weeks prior to the meeting.

### 2.3 Typical Presenters/Attendees at the SMA PRR

- a. NASA program/project manager.
- b. Flight vehicle prime contractor representative.
- c. Supporting NASA SMA organization representative(s).
- d. Range safety officials for the affected ranges and NASA Center range safety representatives.
- e. Representatives from other cognizant state and/or Federal agencies.
- f. Representatives from other involved program/project(s) (e.g., launch vehicle, Space Shuttle, International Space Station).
- g. Representatives from other involved NASA Headquarters Offices, to include Office of Chief Information Officer, Environmental Management Division, Office of Aerospace Technology, and Office of Security Management and Safeguards.

### 2.4 SMA PRR Content/Agenda

The nominal agenda for the SMA PRR contains the following presentations and discussion items:

- a. Associate Administrator for Safety and Mission Assurance (or designee): Objectives of the SMA PRR.
- b. NASA program/project manager:
  - 1) Program/project overview/objectives/schedule.
  - (2) Design reference mission(s).
  - (3) Overview presentations in the following life cycle areas: program/systems engineering management, acquisition management, concept development, hardware design and verification, software design and verification, manufacturing/installation, pre-operations integration and test, and operations.
- c. Certifying/performing Center SMA organization:
  - (1) Mission assurance organizations, responsibilities, reporting relationships, and staffing levels.
  - (2) Planning for oversight and independent assessment of EAV program/project.
  - (3) Mission Assurance Surveillance Plan (see paragraph 3.2).
- d. Each presentation should specifically address the EAV management approach and SMA processes employed by NASA and the prime contractor(s) to ensure that the elements listed in paragraph 5.3 and Table 2 will be met, verified, and can be reviewed at the appropriate level and applicability at the SMA PAR (see Chapter 4). Presentations should include:
  - (1) Policies to be employed (e.g., NASA, government, corporate, voluntary standards, items specified in contract or cooperative agreement).
  - (2) Planning documents to be developed (e.g., risk management, system safety, systems engineering management plan, quality assurance plan, surveillance plan, software assurance plan).
  - (3) Processes to be implemented (e.g., risk management, concurrent engineering process, configuration management, electrical, electronic, and electromechanical [EEE] parts nonconformance disposition).
  - (4) Controls to be employed (e.g., risk management reviews, independent assessment, reporting requirements, surveillance, inspection, oversight, insight).
  - (5) Verification activity to be conducted (e.g., test, inspection, simulation, demonstration, analysis).

## 2.5 SMA PRR Products

Upon completion of the SMA PRR, the Associate Administrator for Safety and Mission Assurance (and/or designee) will issue an initial assessment of the EAV program/project's SMA process(es) to the applicable Enterprise Associate Administrator or Center Director. The report may include:

- a. Recommendations for corrections or additions to the program/project SMA planning.
- b. If the developer has requested indemnification, a preliminary endorsement of whether the developer is following appropriate safety procedures and practices in the development of the EAV.
- c. A schedule for closure of SMA PRR actions and work identified during SMA PRR to support program/project schedules and to be ready to conduct the SMA PAR.
- d. A request for the Enterprise Associate Administrator (or Center Director) to respond to the report with a detailed schedule and the methods to be used for accomplishing the SMA programmatic processes and elements described in paragraph 5.3.

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## CHAPTER 3. Conduct SMA Process Surveillance

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### 3.1 Center Program/Project Management and SMA Responsibilities

3.1.1 The certifying/performing Center(s) for the EAV program/project is responsible for ongoing surveillance of program/project and/or contractor assurance process implementation ([Requirement 21027](#)). Ongoing surveillance includes ensuring the adequacy of program/project and contractor SMA documents, plans, and procedures and observing, verifying, and documenting implementation of assurance processes. The certifying/performing Center SMA organization should perform this ongoing surveillance ([Requirement 30919](#)).

3.1.2 Each involved Center SMA organization shall maintain documentation of the surveillance, oversight, and independent assurance activities per paragraph 3.2 ([Requirement 21028](#)).

3.1.3 Each involved Center SMA Director shall ensure that the Associate Administrator for Safety and Mission Assurance is provided with documentation and information that demonstrates the implementation of assurance processes for all phases of the program/project ([Requirement 21029](#)).

3.1.4 The certifying/performing Center SMA Director and the program/project manager shall approve the surveillance, oversight, and independent assurance activities in the plan defined in paragraph 3.2 ([Requirement 21030](#)).

3.1.5 Prior to completing the Preliminary Design Review (PDR) or equivalent review, and in accordance with NPR 7120.5, NASA Program and Project Management Processes and Requirements, the SMA organization supporting the program/project manager shall develop a finalized SMA surveillance plan detailing SMA surveillance methods, processes, and practices ([Requirement 21031](#)).

### 3.2 SMA Surveillance Plan

The certifying/performing Center SMA organization shall develop a Mission Assurance Surveillance Plan that shall be presented at the PRR (see paragraph 2.4.c) ([Requirement 21032](#)). The intent of the plan is to validate that project SMA processes will address the items listed in Table 2. The plan will describe the process for SMA surveillance and will include:

- a. An overview of objectives and NASA SMA's method for conducting surveillance on the program/project.
- b. NASA SMA's method for reviewing the program/project accomplishment of the listing in paragraph 5.3. The SMA organization will accomplish the assessment of:
  - (1) Program/project SMA plan(s) development and implementation (e.g., system safety plan, quality assurance plan, test/mission plan, risk assessment/management plan, hardware/software assurance plan, independent verification and validation plan, emergency/contingency plan(s), and environmental plans).
  - (2) As-built reviews.
  - (3) The adequacy of the SMA processes to cover all facets of the program.
  - (4) Risk identification, risk management, and risk tradeoffs.
  - (5) Safety and hazard risk identification/analyses and how the risks are closed/mitigated/tracked.
  - (6) Prioritization of the list of the above items as to their criticality.
  - (7) The method for reviewing SMA provisions of external interfaces (e.g., system safety working group, Space Shuttle/International Space Station program, Ground Safety Review Panel, range, international partners/participants).
  - (8) Review of demonstrated and documented compliance with applicable range safety requirements and applicable

Federal, state, tribal, and international law and regulatory requirements.

- c. The scope and plan for SMA independent assessment. The plan shall include who will accomplish the independent assessment ([Requirement 30920](#)).
- d. The SMA organization's method for providing the Associate Administrator for Safety and Mission Assurance with the knowledge and understanding for approval of the SMA Flight Certification.
- e. The method for documenting the safety review processes.

### **3.3 SMA Surveillance Record**

The mission assurance surveillance record shall be developed and maintained ([Requirement 21033](#)). The SMA organization supporting the program/project manager is responsible for recording the surveillance, oversight, and independent activities performed in support of the SMA Surveillance Plan ([Requirement 30921](#)). A summary of the mission assurance surveillance record shall be presented at the SMA PAR ([Requirement 30922](#)).

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## CHAPTER 4. Verify SMA Process Implementation

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### 4.1 Introduction

4.1.1 OSMA conducts an SMA PAR to confirm implementation, completion, and closure of processes which were identified in the SMA PRR and during SMA surveillance and verification activities. The SMA PAR focus is on flight readiness and operational assurance processes. The program/project will address the applicability of the elements listed in Table 2.

4.1.2 The SMA PAR is nominally held 90 to 120 days prior to flight operations. The SMA PAR should coincide with a programmatic review.

4.1.3 Particular emphasis is applied to the system safety program, including system level hazard analyses and risk mitigation. The SMA PAR relies on supporting data (e.g., signed/approved deliverables) to certify implementation of established SMA processes. The SMA PAR includes information from the safety review process that verifies public safety.

### 4.2 SMA PAR Protocol

- a. The Associate Administrator for Safety and Mission Assurance (or designee) and the Enterprise Associate Administrator (or designee) schedule and determine the location for the review. The Associate Administrator for Safety and Mission Assurance (or designee) chairs the review.
- b. OSMA (or designee) develops the agenda 4 to 6 weeks prior to the meeting.

### 4.3 Typical Presenters/Attendees at the SMA PAR

- a. NASA program/project manager.
- b. Flight vehicle prime contractor representative.
- c. Each supporting Center SMA organization representative.
- d. Range safety officials for the affected ranges and NASA range safety representatives.
- e. Representatives from other involved NASA programs/projects such as the launch vehicles, expendable launch vehicles (ELV), Space Shuttle, or International Space Station programs.
- f. Representatives from other cognizant state and/or Federal agencies.

### 4.4 SMA PAR Content/Agenda

The nominal agenda for the SMA PAR contains the following presentations and discussion items:

- a. Objectives of the SMA PAR.
- b. Mission program/project overview/schedule.
- c. Demonstration of compliance with the applicable elements contained in paragraph 5.3 and a listing of open items or exceptions. (Note: Applicability is defined at the SMA PRR.)
- d. Status of vehicle readiness for flight.



- e. SMA organization results and conclusions of oversight and independent assessment of EAV program/project.
- f. Review of mission success criteria.

## **4.5 SMA PAR Recommendations**

4.5.1 Upon successful completion of the SMA PAR (and evaluation of final program/project, range, and FAA documents), the Associate Administrator for Safety and Mission Assurance will issue an assessment of vehicle flight readiness, subject to any final reviews, to the Enterprise Associate Administrator.

4.5.2 In the case of a request for third-party indemnification, the assessment will either support or not support the issuance of indemnification and the decision to become a risk-sharing partner with the developer.

4.5.3 Nominally, assessment letter will include:

- a. Assurance that the safety of the public, astronauts and pilots, workforce, and high-value equipment and property will not be compromised.
- b. Documentation that risks have been managed.
- c. Documentation that mission assurance procedures and practices (i.e., design, manufacturing, test, and verification) are being followed.
- d. Compliance with other Federal and state requirements (e.g., range safety, environmental protection, ground safety, and maritime transportation safety).
- e. Verification of mitigation/disposition of all system safety issues identified in hazard analyses.
- f. Verification of contingency planning processes.
- g. Documentation of assurance process implementation by listing assurance activities and the key personnel involved with these activities.
- h. Extent of independent assessments.
- i. Documentation of assigned responsibility for the closure of any open items required for closure prior to flight.

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## CHAPTER 5. Assess SMA Flight Readiness

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### 5.1 EAV SMA Flight Assessment

5.1.1 When there is a program certification of readiness for flight, the Associate Administrator for Safety and Mission Assurance (or designee) shall be a signatory ([Requirement 21103](#)). Prior to concurrence on the certification of readiness for flight, the Associate Administrator for Safety and Mission Assurance should review and verify the status of any open items identified in the assessment as they pertain to the readiness for flight.

5.1.2 Following the SMA PAR, the EAV program/project manager shall develop the plan and schedule leading to final SMA Flight Assessment prior to flight ([Requirement 21104](#)). (In the event that there are no open items requiring closure, the Associate Administrator for Safety and Mission Assurance may adopt the assessment letter defined in paragraph 4.5.3 as the final SMA Flight Assessment.)

5.1.3 For any reviews being held after the SMA PAR, the certifying/performing Center Director and the EAV program/project manager shall ensure that the Associate Administrator for Safety and Mission Assurance (or designee) is invited to participate in the final review(s) ([Requirement 21039](#)). Those review(s) shall include any items that may affect the SMA flight certification or closure of open items identified in the SMA Flight Assessment ([Requirement 30923](#)). Upon closure, the Associate Administrator for Safety and Mission Assurance shall indicate that the activities in paragraph 5.3 determined to be appropriate have been successfully completed and that all identified mission safety risks have been demonstrated by the program/project to be controlled to an acceptable level ([Requirement 30924](#)). The signature indicates OSMA concurrence of flight readiness.

5.1.4 At approximately 2 weeks prior to the start of the mission, the Associate Administrator for Safety and Mission Assurance and the Enterprise Associate Administrator (or designee(s)) will conduct a tag-up telecon or meeting with the EAV program/project manager, the certifying/performing Center Director(s), and Center SMA Directors(s), or designees as approved by the Associate Administrator for Safety and Mission Assurance, to reaffirm concurrence that the mission can proceed.

### 5.2 Third-Party Indemnification Requests

Third-party indemnification requests shall be processed as follows:

- a. A developer seeking indemnification will make its request in accordance with the procurement contract or other governing agreement, as applicable ([Requirement 21040](#)).
- b. A contractor or other party who desires indemnification against third-party claims shall make the request to the contracting officer as set forth in the contract or agreement ([Requirement 31527](#)).
- c. The contracting officer or other NASA official receiving the request shall forward the request and any contract- or agreement-required proof of insurance to the program/project manager ([Requirement 31528](#)).
- d. The program/project manager shall forward the request, the proof of insurance, copies of the final assessment letter, and any "maximum probable loss" calculation to the Enterprise Associate Administrator ([Requirement 31529](#)).
- e. The Enterprise Associate Administrator sends third-party indemnification requests, with the recommendations from the Associate Administrator for Safety and Mission Assurance, the Chief Financial Officer, and the NASA General Counsel, to the NASA Administrator for approval ([Requirement 31530](#)).

### 5.3 Basic Set of EAV Program/Project Elements for EAV Program/Project SMA Flight Assessments

Table 2 contains the listing of the SMA programmatic elements that are nominally applicable to EAV program/project SMA flight assessments. SMA management will use the flight assessment elements listed in Table 2 in acquiring the knowledge and understanding needed to ensure an EAV is ready for flight from the SMA perspective. Table 2 is not intended to be all-inclusive, but is representative of the key element areas and should be used at milestone reviews to assess the level of SMA process maturity.

The Center SMA organizations are responsible for evaluating the quality and thoroughness of the requirement implementation/products ([Requirement 21041](#)). The OSMA (or designee) representatives evaluate the what, the process, and who verifies the requirement implementation. Additionally, the OSMA representatives spot-check requirement products for quality and thoroughness. The Reference Documentation column in Table 2 provides the reference to the base requirements. Additionally, the quality record to be stored after each use of Table 2 shall describe how each element was verified (direct or indirect) and who did the verification ([Requirement 31531](#)).

**Table 2: SMA Flight Assessment Elements**

Endorsement	Element	Reference Documentation	Notes
1.	Program management documentation required per NPR 7120.5 has been completed and the SMA paragraphs are current. NPR 7120.5 SMA-related documentation includes: Program Commitment Agreement (PCA), Program Plan, Project Plan, Configuration Management Plan, Risk Management Plan, System Safety Plan, NASA SMA Plan, Prime Contractor SMA Plan, and System Engineering Management Plan.	NPR 7120.5, Paragraphs 4.3, 4.6, and Appendix E	
2.	Program management documentation required per Risk-Based Acquisition Management (R-BAM) in the NASA FAR Supplement has been completed and the SMA paragraphs are current. R-BAM SMA-related documentation includes: source evaluation board membership, acquisition planning (SMA and risk management participation), risk-based contractor surveillance plan, instructions to offerors and evaluation criteria, quality assurance surveillance plan developed for the statement of work, and pre-award audit planning.	NASA FAR Supplement NPR 7120.5, Paragraph 4.5.5	

3.	Mission Assurance Surveillance Record has been developed and maintained.	NPR 8705.x, Chapter 3 NPR 8735.2 NPR 1441.1 NPR 8715.3, Paragraph 3.10	
4.	The program/project design and operations requirements are managed in a controlled and maintained manner.	NPR 8715.3, Paragraphs 1.3.4 and 3.11	
5.	The flight articles (both hardware and software) have been built to the applicable specifications and drawings. Any exceptions to the design requirements have been approved and documented.	NPR 8715.3, Paragraphs 1.3.4 and 3.11	See SSP 30695.
6.	Limited-life hardware (time, cycle) has been identified, addressed, and documented, and maintenance planning has been addressed.	NPD 8720.1	See SSP 50231.
7.	Hardware design for risk management (e.g., failure modes and effects analysis, hazard analysis) is planned and implemented. A list of safety and mission critical hardware and software items (i.e., critical items, mission hazards) has been identified and addressed.	NPD 8720.1	See SSP 30234. See SSP 50231.
8.	All reported hardware/software problems and nonconformances have been resolved and/or accepted.	NPD 8720.1, Paragraphs 1.c and 5.c	
9.	Hardware test, verification, validation, quality assurance, quality control are planned, implemented, and documented.	NPR 7120.5	

10.	For operations outside of the control of NASA, consultations have been conducted with the NASA General Counsel, the Assistant Administrator for External Relations, and the Associate Administrator for Safety and Mission Assurance regarding whether the outside entity has adequately addressed safety provisions.	NPD 8700.2, Paragraph 5.f.4 NPR 1000.3 NPR 8715.3, Paragraph 1.12	
11.	Compliance with host range requirements for public and worker safety for operations and agreement by range safety personnel to include flight termination system (FTS) security has been demonstrated.	NPR 8705.x, Appendix B NSTISS Policy Number 12	See KSC HB 1700.7. If U.S. DoD Range: see EWR 127-1, Paragraph 1.4.
12.	The program/project has identified the external interfaces for safety. Applicable review processes have been completed.	NPD 8710.2, Paragraph 1.b NPR 8705.x, Appendix B NPR 8715.3, Paragraphs 1.3, 1.11, 3.2.5, 3.3, 3.5, and Chapter 6 EWR 127-1, Paragraph 1.4	
13.	The program/project has notified the appropriate agencies for issuance of public safety notices (i.e.; FAA for Notice to Airmen, USCG for Notice to Mariners).	NPD 1000.1 (NASA Values) NPD 8700.2, Paragraph 5.d	See SSP 30559. See NSTS 13830.
14.	Risks associated with any hardware, software, and services (e.g., launch services) provided to the program/project have been reviewed and mitigated or accepted by NASA.	NPD 7120.4 NPD 8700.2, Paragraph 5.f.1 NPR 7120.5 NPR 8705.x, Paragraph 4.4 NPR 8715.3, Paragraph 1.3.7	See NASA review of X-43A booster SMA program. See X-43A June 2001 mishap report conclusions and recommendations. See DC-XA Mishap Report (Sept 1996). See GAO Testimony (GAO-01-825T), June 20, 2001.

15.	The mission assurance analysis and assessments have been completed, and identified risks have been accepted.	NPD 8710.2, Paragraph 1.b NPD 8720.1, Paragraph 5.c NPR 8715.3, 1.3, 1.11, 3.2.5, 3.3, 3.5-3.8, Chapter 6 EWR 127-1, Paragraph 1.4	See SSP 30309. See SSP 30324.
16.	The program/project has defined a safety process, and identified risks have been mitigated and/or accepted.	NPD 8710.2, Paragraph 1.h. NPR 8715.3, Paragraphs 1.3, 1.11, 3.2.5, 3.3, 3.5-3.8, and Chapter 6	See SSP 30599. See NSTS 13830.
17.	The program/project has defined reliability and maintainability planning and provided for its implementation.	NPD 8720.1	
18.	Aviation safety program requirements have been met.	NPR 8715.3, Chapter 7	Applicable to all airplane-like EAV's.
19.	A formal orbital debris assessment has been performed.	NPD 8710.3 NPR 8705.x, Appendix B	Applicable to all programs and projects that may generate orbital debris.
20.	All sites, facilities, personnel, and procedures are ready to safely support atmospheric and/or on-orbit operations. Flight rules and the flight test plan have been reviewed for SMA impacts and approved.	NPR 8715.3, Chapter 6	
21.	The mission support team and crew have been identified, training/certification is completed, and personnel are ready to support the atmospheric and/or on-orbit operations. Mission support team and crew procedures have been defined and adopted.	NPR 8715.3, Chapter 6	
22.	All personnel, facilities, ground support equipment, and procedures are ready to support integration activities into the launch vehicle.		

23.	Required software IV&V has been identified, planned, conducted, and documented.	NPD 8730.4	
24.	Final ground and flight software loads have been validated and verified and are acceptable.		
25.	All critical data and critical communications are protected.	NPR 2810.1 NPR 8705.x, Appendix B.6 NSTISS Policy Number 12	For FTS and other safety critical functions.
26.	An emergency preparedness and contingency plan has been developed and covers recovery from all flight test operation anomalies.	NPD 8710.2, Paragraph 5.g and Chapter 7 NPD 8621.1 NPR 8715.3, Paragraph 1.6.1	
27.	All pressure vessels being used are certified as safe.	NPD 8710.5, Paragraphs 1.a, 1.g and 1.h ANSI/AIAA S-080-1998.	See KHB 1700.7. See NSTS 1700.7. See SSP 50004. See SSP 50021.
28.	The program/project has been reviewed for radioactive materials and, if present, nuclear launch safety approval obtained.	NPR 8715.3, Chapter 5	See KHB 1700.7. See NSTS 1700.7. See SSP 50004. See SSP 50021.
29.	The program/project has included Alerts, Government-Industry Data Exchange Program Alerts, and NASA Alerts in the risk management program, and they have been closed/accepted.	NPD 8720.1, Paragraph 5.c.5	
30.	The NASA Limited Life Item System and Preferred Practices System have been used to document and investigate safety, reliability, maintainability, and quality assurance techniques.	NPD 8720.1, Paragraphs 5.a.4 and 5.c.6	
31.	All relevant NASA Safety Reporting System reports have been assessed.	NPD 8700.1	

32.	All open work items applicable to flight, from operations and SMA reviews, have either been closed or are planned for closure before flight.		
33.	Compliance with NPR 8705.x, Human Rating Procedural Requirements for Space Flight Systems, has been demonstrated.	NPR 8705.x	
34.	Program flight certification process(es) has been followed and SMA findings have been addressed. There are no open SMA issues that may preclude safe operations.	NPD 8700.2, Paragraph 5.b.2	



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## Appendix A. Acronyms

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CFR	Code of Federal Regulations
CoFR	Certificate of Flight Readiness
DoD	Department of Defense
E <sub>c</sub>	Casualty Expectation
EAV	Experimental Aerospace Vehicle
EEE	Electrical, Electronic, Electromechanical
ELV	Expendable Launch Vehicle
EWR	Eastern and Western Ranges
FAA	Federal Aviation Administration
FRR	Flight Readiness Review
FTS	Flight Termination System
IA	Information Assurance
IV&V	Independent Verification and Validation
JPL	Jet Propulsion Laboratory
KHB	Kennedy Space Center Handbook
NPR	NASA Procedural Requirements
NPD	NASA Policy Directive
NSS	NASA Safety Standard
NSTISS	National Security Telecommunications and Information Systems Security
NSTS	National Space Transportation System
OSMA	NASA Headquarters Office of Safety and Mission Assurance
PAR	SMA Preflight Assessment Review
PCA	Program Commitment Agreement
PDR	Preliminary Design Review
PRR	Process Readiness Review
R-BAM	Risk-Based Acquisition Management
SMA	Safety and Mission Assurance
SSP	Space Shuttle Program
USCG	United States Coast Guard

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## Appendix B. Summary of Minimum Fundamental U.S. Federal Aviation Administration (FAA) and Eastern and Western Range (EWR) Safety and Mission Assurance Process Requirements for Experimental Aerospace Vehicle (EAV) Programs/Projects

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The following six basic program/project requirements are summarized from 14 CFR Chapter III (FAA) and the range safety requirement documents (i.e., EWR 127-1). These requirements are not to be considered as all-inclusive but are provided to assist the program/project manager in understanding which fundamental requirements must be met. These requirements form the basis for developing an acceptable safety risk mitigation plan for EAV projects.

### B.1 Casualty Expectation

A risk assessment is nominally performed by an independent entity with support from the project. The project is required to collaborate with range safety officials on an assessment of the EAV's probability of failure to be used in risk calculations ([Requirement 21107](#)). Operations that can be performed in sterilized airspace (accommodated by the affected range(s) and/or FAA) may do so without an expectation of casualty ( $E_C$ ) calculation based on the fact that there will not be any persons or property to injure/damage. The numerical standard shall be consistent with the current Range Commanders Council Standard 319-00, Common Risk Criteria for National Test Ranges. This standard is twofold. For a single test mission, an individual's risk per mission shall be less than one chance in a million ( $1.0 \times 10^{-6}$ ) [does not apply to flight crew] ([Requirement 31533](#)). Second, the collective risk of the population exposed to risk from the test mission shall be less than 30 chances in a million ( $30 \times 10^{-6}$ ) ([Requirement 31534](#)). This is the basic  $E_C$ , which underlies all discussion of risk. By having a specific goal, the program/project can allocate risk in order to meet this goal while maximizing the mission success objectives. This risk level is assessed against the overall mission and takes into account hardware, ground track, and operational scenarios. Implicit in the development of overall risk, the project will be required to identify and assess potential failures and their impact on risk ([Requirement 31535](#)). Requests for variance to the  $E_C$  requirements must be addressed through the host range commander ([Requirement 31536](#)).

### B.2 Operations

The EAV operator should use a structured analytical approach in preplanning for orbital, suborbital, and entry flight by developing detailed flight rules, procedures, and checklists prior to the Flight Readiness Review, for both nominal and contingency operations. The EAV operator shall document scenarios that allow for continued safe flight and landing or flight termination in a manner that minimizes risk in off-nominal situations ([Requirement 21109](#)).

### B.3 Deorbit Burn

The reliability of the deorbit burn system to achieve controlled entry to the targeted landing site or debris footprint shall be at least 0.99 ([Requirement 21109](#)). The intent is to provide some assurance that the vehicle will be deorbited in a predictable manner. Requests for variance to this requirement must be addressed from the program manager through the Associate Administrator for Safety and Mission Assurance ([Requirement 31537](#)).

### B.4 Commit to Deorbit

An entry operation may not be initiated until conditions critical to safety have been confirmed ([Requirement 21110](#)).

Commit to deorbit shall be initiated (enabled) via EAV operator control ([Requirement 31538](#)). Flight path and landing zone preparation (i.e., airspace clearance, notices, alerts) may have a major impact on personnel safety and E<sub>C</sub> estimates.

## B.5 Notification

The EAV operator shall coordinate, develop procedures, and demonstrate (in conjunction with the host range and/or FAA), prior to launch and reentry, the capability to notify maritime and aviation authorities with sufficient time to clear the trajectory, ground-track, and emergency abort areas (if applicable) of traffic ([Requirement 21111](#)).

## B.6 Flight Termination

The requirement for a flight termination system (FTS) shall be determined by NASA with the cognizant range commander(s) for the range(s) on which the vehicle will perform its flight testing to ensure that the FTS is not susceptible to unauthorized or unwanted signals ([Requirement 21112](#)). NASA EAV program/project managers should consider the use of a secure FTS. The method and design of the FTS shall be established in negotiations with range safety officials early in the development of EAV's ([Requirement 31539](#)). The FTS security assessment shall be performed in accordance with National Security Telecommunications and Information Systems Security Policy Number 12, National Information Assurance Policy for U.S. Space Systems, NPR 2810.1, Security of Information Technology, and the host range documentation ([Requirement 31540](#)). The decision to use a secure FTS will be made by NASA and the cognizant FTS organization in accordance with NPR 2810.1. Additionally, a certified Range Safety Officer shall perform the real-time hazard mitigation actions ([Requirement 31540](#)).